MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2021/2022

DEE5056 – POWER ELECTRONICS

(DEE)

15 AUGUST 2022
9:00 am – 11:00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages excluding cover page with 5 Questions only.

2. Attempt **ALL (5)** questions. All questions carry equal marks and the distribution of the marks for each question is given.

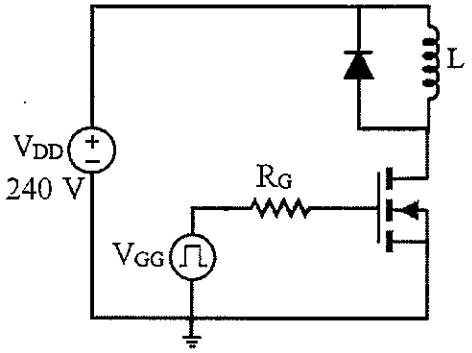
3. Please write all your answers in the Answer Booklet provided.

Question 1 [20 marks]

(a) Briefly describe **THREE (3)** categories of power semiconductor devices based on device characteristics in the power circuit. Provide an example for each category.

[9 marks]

(b) Figure 1 shows a MOSFET with clamped inductive load operating at a switching frequency of 10 kHz. Inductance of the load is large such that the load current is constant at a value of 13A and the transistor off state time is twice longer than the on state time. Calculate the total power loss incurred in the switch. [11 marks]



$R_{DS(on)} = 1\,\Omega$
$\tau_{on} = \tau_{off} = 5\mu s$
$I_{D(off)} = 0.1A$

Figure 1

Continued...

Question 2 [20 marks]

(a) Briefly describe for the following terms:

(i) Commutation [2 marks]

(ii) Line commutation [2 marks]

(iii) Forced commutation [2 marks]

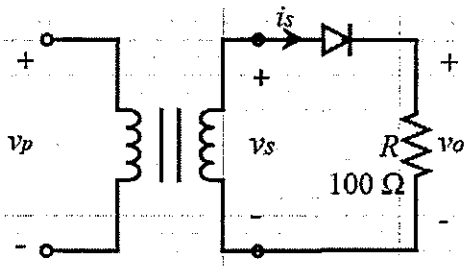
(b) Figure 2 shows a single phase half wave rectifier with resistive load.

(i) Determine for the following parameters:

1. Average output voltage ($V_{o,avg}$) [2 marks]
2. RMS output voltage ($V_{o,rms}$) [2 marks]
3. Ripple voltage (V_{RL}) [2 marks]
4. Ripple voltage factor (K_v) [2 marks]

(ii) Draw following waveforms for one complete cycle: 100 Ω

1. Output voltage (v_o) [2 marks]
2. Diode voltage (v_D) [2 marks]
3. Output current (i_s) [2 marks]



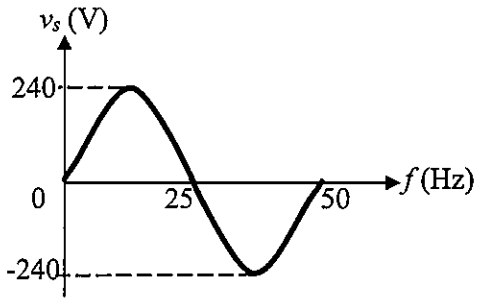


Figure 2

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Question 3 [20 marks]

A buck–boost converter supplied with 24 V source voltage has 0.35 A average source current. The converter operates under continuous conduction mode and generates 16 V output voltage at 20 kHz with duty cycle of 0.4. The converter has maximum inductor current less than 1A and ripple voltage across the resistive load is not more than 1%. Determine for the following parameters:

(a) Average inductor current (I_L). [2 marks]

(b) The load resistance value (R). [2 marks]

(c) The inductance value needed for this converter (L). [4 marks]

(d) The capacitance value needed for this converter (C). [4 marks]

(e) Draw the equivalent circuit during switch open and switch close interval. [4 marks]

(f) Draw the voltage and current waveforms of the inductor. [4 marks]

Continued...

Question 4 [20 marks]

(a) Draw the output current and output voltage waveforms single phase switch mode inverter. Hence, briefly describe the four quadrants of operation.

[8 marks]

(b) Figure 3 shows a half bridge inverter operating at a frequency of 60 Hz. The Fourier Series expression for output voltage is given as

$$v(\omega t) = \sum_{n=1,3,5}^{\infty} \frac{4V_S}{n\pi} \sin n\omega t$$

(i) Write the Fourier equation for the third harmonic. Hence, find the harmonic factor. [6 marks]

(ii) Find the peak load current. [6 marks]

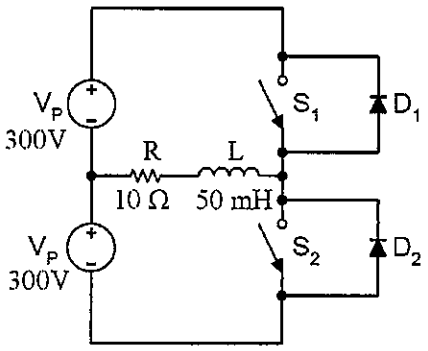

Figure 3

Continued...

Question 5 [20 marks]

(a) Provide **FOUR (4)** shortcomings of switch mode inverters. [8 marks]

(b) Figure 4 shows a load resonant converter and the output current waveform. The converter operates at 1 kHz with R = 10 Ω, L = 10 mH and C = 10 nF.

(i) Complete following table by indicating the state of conduction for each switch at the corresponding time interval. [4 marks]

(ii) Calculate for the circuit turn off time (t_{off}). [8 marks]

	Switch	
Time Interval	T_1	T_2
$0 < t < t_1$		
$t_1 < t < T/2$		
$T/2 < t < t2$		
$t_2 < t < T$		

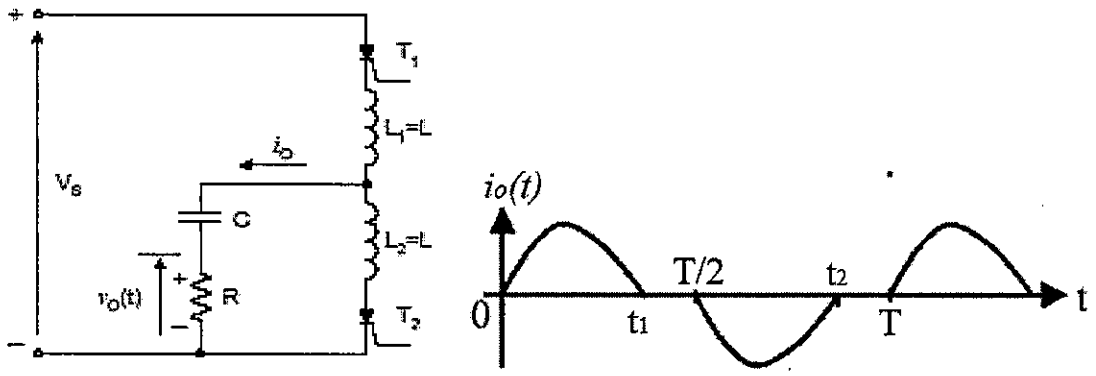

Figure 4

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